

MISSION TO PLANET EARTH

EDUCATION STRATEGY



March 1996



Headquarters

Washington, DC 20546-0001

Dear Colleagues and Customers:

The ultimate product of Mission to Planet Earth is education in its broadest form. Our vision is a sustainable Earth system science education program rooted in strong principles and objectives. Collaboration, dedication, and attention to customer needs have defined a foundation from which future endeavors will continually enhance the understanding of our changing planet.

NASA's Mission to Planet Earth (MTPE) Enterprise provides long-term studies of the Earth system needed to answer critical questions about how the global environment will affect us now and in the future. The unique vantage point of space provides the global perspective needed to better understand how all of the parts of the Earth's environment—air, water, land, and life—interact and make life possible. Data and analyses from MTPE, which includes extensive cooperation and contributions from other Federal agencies and other nations, are revealing some of the Earth's secrets. But the most revealing—and useful—discoveries are yet to come.

The Mission to Planet Earth Strategic Enterprise Plan places the goal of information dissemination on a par with scientific discovery. The Mission to Planet Earth Education Strategy characterizes the overriding principles, objectives, and plan for ensuring that the results of our science communication efforts are successful. This plan is the result of outstanding efforts on the part of the MTPE Education Strategy Team, which is a marriage of MTPE scientists and NASA education professionals from Headquarters and Field Centers involved in Earth system science research coupled with ongoing input from groups and individuals outside NASA.

This document emphasizes the key role that educators play in training future generations of citizens about their home planet and how it works. By training current and future educators, providing curriculum-relevant enhancement products, working with the education system, and providing enriching research opportunities for students, we have defined a strategic approach to formal education that will ensure that our program best meets customer needs.

Having established the groundwork for a long-term relationship with our broad spectrum of customers, we are confident that our collaborations will lead to a more informed and environmentally aware public. We look forward to working with you to achieve this goal.

A handwritten signature in black ink, appearing to read "Charles F. Kennel".

Charles F. Kennel
Associate Administrator for
Mission to Planet Earth

A handwritten signature in black ink, appearing to read "Frank C. Owens".

Frank C. Owens
Director
Education Division

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SECTION I

Introduction

The Mission to Planet Earth (MTPE) program is NASA's contribution to developing a vastly improved understanding of the Earth. The program is designed to address the most fundamental uncertainties and questions associated with the global environment. The unique vantage point of space provides information about the Earth's air, land, water, and life—and the interactions among them—that is not available using any other means.

Working in concert with its interagency and international partners, NASA seeks through MTPE to substantially improve our understanding of the natural processes that govern the global environment and to assess the effects of human activities on these processes. A better understanding will yield improved weather forecasts, tools for managing agriculture and forests, information for fishermen and coastal planners, and, eventually, an ability to predict how climate will change in the future. Today's program is laying the foundation for long-term environmental and climate monitoring and prediction. Potentially, this will provide the understanding needed in the future to support difficult decisions regarding the Earth's environment.

While the ostensible goal of MTPE is scientific understanding, the ultimate product of the program is education in its broadest form. Objective 2.2 of the MTPE program, as cited in the MTPE Strategic Enterprise Plan, is to “foster the development of an informed and environmentally aware public.” Within this context, contributions by MTPE to the advancement of formal education

are a major aspect of how the success of the program will be measured. Formal education and professional development provide a structured opportunity to communicate the content of MTPE to a large community.

MISSION TO PLANET EARTH EDUCATION STRATEGY

In support of NASA's education plan, the Office of MTPE has worked with NASA's Education Division to establish a focused, sustainable education strategy. Participants in the strategy development process include science and education officials at Headquarters and each of the NASA Field Centers that conduct MTPE education: Ames Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory, Johnson Space Center, Langley Research Center, Marshall Space Flight Center, and Stennis Space Center.

The Office of MTPE and NASA's Education Division have been working closely together to implement a set of successful, formal education activities at Headquarters and the Field Centers. These activities will yield a sustainable and coherent education program for MTPE, consistent with the principles, objectives, and priority elements outlined in this MTPE Education Strategy document.

This strategy document supports the MTPE Strategic Enterprise Plan and is designed to be both living and active. The program will change as customer and program needs dictate. The prioritization of program strategies and budget planning for the MTPE Education Program will reflect the content contained within this text.



SECTION II

Overriding Principles and Objectives

MTPE has established several overriding principles to guide the development and implementation of the MTPE Education Program, as follows:

- Demonstrate relevance to society
- Operate and work within NASA's strategy for education
- Focus the implementation of a sustainable Earth system science education program that is consistent with externally imposed education standards
- Increase the involvement of MTPE scientists in education
- Involve teachers in the development and decision-making aspects of education activities
- Coordinate (and perhaps integrate) strategy and programs with other agencies/organizations
- Ensure equity and diversity in all MTPE education activities
- Leverage the resources of external groups

These guiding principles define our approach to achieve the following specific objectives:

- Train the next generation of scientists to use an interdisciplinary Earth system science approach
- Continue to educate and train educators as research evolves and capabilities change
- Raise awareness of policymakers and citizens to enable prudent policy determination regarding global change

- Improve science and mathematics literacy
- Strengthen the interface between educators and scientists and secure greater support by scientists for broad education efforts
- Explore mechanisms to leverage the development of materials and products, where reasonable, to:
 - Increase resources availability
 - Increase the knowledge base
 - Encourage the development of an external capability, expert in translating scientific research into usable forms for a continuum of information customers

The prioritization of educational activities is not clear cut. To meet the objectives above, a complementary set of activities, using the various implementation approaches, must be performed. However, there are certain priority elements to consider when implementing a focused, sustainable program. First, we must maintain current support for graduate students and for the establishment of curricula in universities that pursue an interdisciplinary Earth system science approach. This is intended to yield a more interdisciplinary community in the near term to analyze data from the Earth Observing System (EOS) missions and provide accurate information on global change to policymakers. Second, MTPE must educate present and future teachers if its results and discoveries are to reach a national, diverse population of students. Finally, as technology allows for increased hands-on, interactive learning, a priority will be placed on the incorporation of technology in precollege activities.

SECTION III

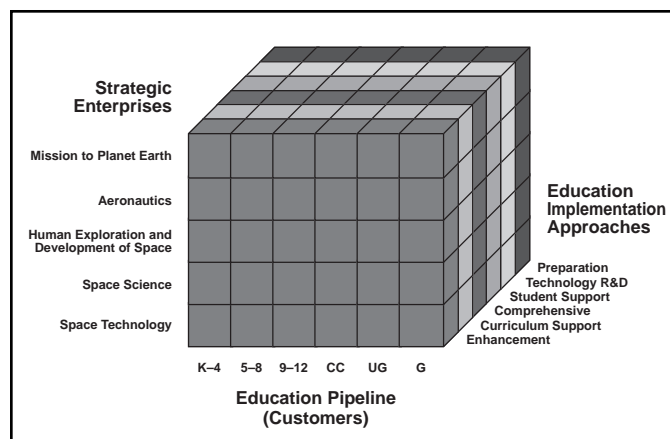
NASA's Education Framework: Priority Elements

All NASA education activities are part of NASA's Education Framework. Figure 1 illustrates the framework, which includes three components: program content, education levels, and implementation approaches. The *program content* reflects MTPE's Earth system science approach to understanding our changing planet. The *education levels* are divided into kindergarten through fourth grade, fifth through eighth grade, ninth through twelfth grade, and undergraduate, community college, and graduate levels. The *implementation approach* defines the purpose of the activity.

The MTPE Education Strategy recognizes the importance of a complement of approaches to ensure a well-rounded education program. A description of each of the primary MTPE education implementation approaches follows.

Teacher/Faculty Preparation and Enhancement—Programs, resources, and facilities designed to enhance teacher/faculty knowledge and skills that result in positive student outcomes.

- Introduce the application of mathematics, science, and technology in student learning using MTPE content
- Enhance teachers' capabilities to design lessons and experiences that use scientific inquiry to affect student learning
- Encourage a "multiplier" effect to extend the benefits of the in-service program beyond participants to other teachers and students
- Provide access to and promote the use of MTPE-related materials and information resources.
- Balance gender and increase the ethnic diversity of program participants
- Encourage collaboration between schools of education and scientific/technical faculties to develop innovative approaches to teacher preparation for student learning



NASA's Education Framework

- Enhance faculty research skills in Earth system science
- Balance participation so that a cross section of colleges and universities is represented (that is, community colleges, 4-year institutions, institutions that serve significant numbers of underrepresented groups, and so on)
- Provide opportunities for curriculum expansion/revision that align with MTPE program themes

Curriculum Support—The development, utilization, and dissemination of science, mathematics, and technology instructional products based on MTPE's unique mission and results (including support for the development and augmentation of higher education curricula).

- Develop instructional products in support of national education standards that include teacher preparation and enhancement components
- Disseminate curriculum support products to targeted customers and facilitate their use in NASA education programs and externally implemented activities
- Review existing products in partnership with customers and higher education curriculum designers and replace dated material



- Support the development of interdisciplinary courses in science and technology, utilizing MTPE's unique program content

Systemic Change—Efforts to enhance the capabilities of the broad educational community through individual/collaborative efforts with a range of partners and/or through infrastructure changes.

- Contribute to K–12 mathematics, science, and technology education by promoting the involvement of various community sectors
- Enhance the participation of schools and organizations serving a significant number of underrepresented groups
- Enhance the research and educational capabilities of the higher education community through partnerships, linkages, and collaborations
- Enhance the collaborative capabilities of a diverse set of academic institutions serving a significant number of underrepresented groups

Student Support—The provision of experiences and exposure to the MTPE program, research experiences for students at MTPE sites, and support in the form of training students in the sciences, mathematics, engineering, and technology.

- Provide experiences and information that encourage student interest in mathematics, science, engineering, and technology
- Provide exposure to research and/or research experiences to promote mathematics, science, engineering, and technology career awareness
- Increase the participation of underrepresented groups
- Provide experiences that facilitate the transition from undergraduate work to graduate studies in MTPE-related interest area
- Encourage continuing professional development and contributions to research in MTPE-related disciplines



SECTION IV

Objectives and Strategies

Objective 2.2 of the MTPE Strategic Enterprise Plan is to “[f]oster the development of an informed and environmentally aware public.” NASA Headquarters and each of the Field Centers must work together, in coordination with NASA’s Offices of Education, Public Affairs, and Legislative Affairs, to convey the results of the various research programs in an effective and focused manner for diverse audiences.

Formal education is one critical component of the MTPE Education Program. There is a compelling need to influence emerging Earth scientists to think of the Earth as an integrated system. Data from the EOS program must be interpreted and analyzed from an interdisciplinary perspective. Therefore, a stable graduate-level student support activity must continue. However, other student support activities at lower grade levels must be weighed against their ultimate impact on the goal of fostering an educated citizenry. It is necessary to focus instead on “educating the educators” to implement the “multiplier” effect, whereby one teacher may reach other teachers and eventually hundreds of students.

In response to increasing demands for information during an era of limited resources, it is essential to leverage educational efforts with other Government agencies and outside organizations that maintain Earth system science educational programs. Leveraging in various forms is necessary to build a sustainable education program within MTPE. The broader public outreach task must also use leveraging as part of its plan. Outside organizations are often more capable of translating, packaging, and disseminating data to the various information customers of MTPE.

STRATEGY: Support student enrichment and research opportunities to train the next generation of Earth system scientists

Student support activities are exciting projects that involve all of the Field Centers. A proper balance must be sustained, with a strong focus on undergraduate and graduate students to maintain a pipeline of well-

trained scientists and engineers. Although K–12 student support activities are appealing to the fortunate students who are able to take part in the activities, the majority of students are left out because of sheer numbers. Therefore, the concentration of the K–12 activity for MTPE must be on the teachers.

MTPE supports a balance of institutes, academy programs, and fellowships for students of higher education. The largest student support activity in which MTPE is involved at the precollege level is Global Learning and Observations to Benefit the Environment (GLOBE). This international precollege program provides students with the opportunity to undertake hands-on science. Students across the globe take measurements of the atmosphere, hydrosphere, and biosphere and input the data into a central processing facility. Feedback is provided to the students so that they can see rapid results of their findings, correlated with data from students around the world. The National Oceanic and Atmospheric Administration (NOAA), NASA, and the National Science Foundation (NSF) are the primary agencies supporting this program.

NASA is known for its support of school science fairs and visits to its Centers. However, much more in the student support area is offered by the Agency. The Summer High School Apprenticeship Research Program (SHARP) is designed to attract underrepresented minorities and women to science and aerospace careers. SHARP students carry out assignments under the supervision of a mentor, prepare reports, and participate in a variety of enrichment activities. NASA’s JOVE (JOint Venture) program is a cooperative endeavor between NASA and participating universities to develop research capabilities, promote science and engineering education, and encourage outreach activities.

STRATEGY: Emphasize nationwide pre-service and in-service teacher enhancement programs that enable educators to incorporate Earth system science concepts into their classrooms



Teacher enhancement activities are the primary focal point of the MTPE strategy. By reaching teachers, as opposed to individual students, the multiplier effect occurs. In times of increased demands for information and declining budgets, it is essential to leverage the impact that teachers and curriculum developers make on the formal education system. Therefore, an increased emphasis on “training the trainers” has developed within the MTPE Education Program. Pre-service teacher training provides an opportunity for Earth system science to be introduced as part of a teacher’s degree program or certification. This increases the opportunity for future teachers to incorporate Earth system science into their integrated curricula. MTPE encourages the development of teacher enhancement products that can be distributed in an electronic format and presented in conjunction with workshops or other hands-on training opportunities. This provides the best opportunity to maximize the number of teachers engaged in the enhancement process.

IN-SERVICE TEACHER ENHANCEMENT

Distance learning is being incorporated in MTPE in-service teacher enhancement programs to make nationwide coverage possible. Classroom of the Future and MTPE are joining forces to bring in other partners to establish a long-term, in-service teacher enhancement program. This will provide an opportunity for precollege educators to

earn continuing education credit by participating in a multimedia distance learning program that emphasizes Earth system science and its application to the classroom. Through satellite downlinks, Internet connections, video tapes, and local facilitation, teachers will be exposed to a unique approach to studying the Earth. They will also receive hands-on training with products that support the emerging national education standards so that they can share knowledge of the Earth’s interactive nature with students in their classrooms.

PRE-SERVICE TEACHER ENHANCEMENT

A nationwide pre-service curriculum enhancement program is being coordinated with NASA Headquarters’ Education Division. The existing program is designed to develop and disseminate a national framework for enhancing interdisciplinary Earth system science literacy and knowledge for teachers in the 21st century. To accomplish this goal, university teams from across the country will take part in a competitive selection process for awards. Teams consist of principle investigators from science and education departments. They will participate in the program together and develop courses or course modules for use in pre-service certification courses. MTPE will support those teams that propose to implement new courses or modify existing courses to emphasize Earth system science.



In-service teachers participate in the Maryland Initiative: Earth and Environmental Science Teacher Ambassador Program.



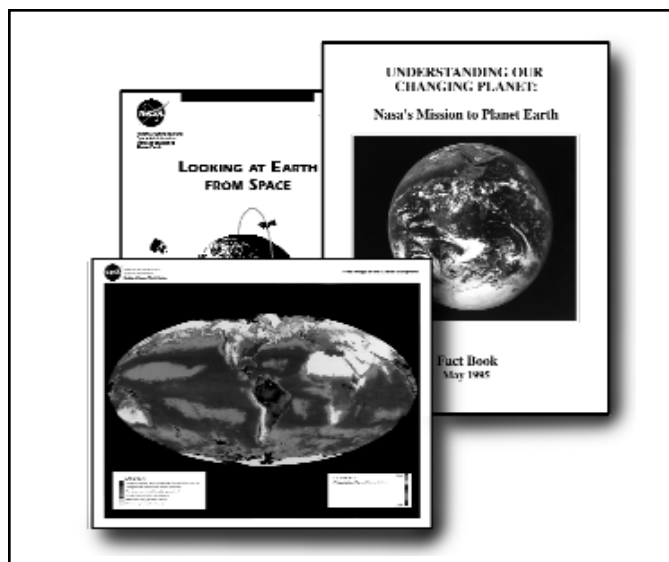
CURRICULUM SUPPORT

Across the Agency, many tools and materials have been developed that demonstrate scientific results in a usable format for educators. These serve as flexible instruments for educators to enhance their curricula. The main objective of MTPE curriculum support is the development of supplemental educational materials that enhance curriculum and teaching standards. This must be done in a manner consistent with frameworks and principles of education reform and reflective of ethnic and gender diversity. In support of this objective, MTPE has adopted guidelines (Appendix 2) for developing curriculum support materials. These guidelines, in concert with the unsolicited proposal process (Appendix 1), will enable MTPE to develop curricula and products that adhere to the National Science Standards and are best suited for the needs of teachers and students across the Nation.

Because NASA's ability to work directly with teachers through its Field Centers or in their schools is limited, the Agency has created a three-part approach to disseminate information. In conjunction with other parts of NASA, the Office of MTPE uses each of the following mechanisms to disseminate information and educational products effectively and efficiently to a large segment of educators and the general public:

- A physical presence in each state
- Electronic delivery systems
- High-leverage activities through partnerships with other educational, industrial, and nonprofit associations

To facilitate the Agency's impact on the national education system, NASA and MTPE are developing a physical presence in each state. Through the Teacher Resource Center Network (TRCN), NASA's Central Operation of Resources for Educators (CORE), and the National Space Grant College and Fellowship Program, NASA is building a national infrastructure for program information dissemination. This infrastructure represents a significant part of NASA's plan to reach and leverage its programs and materials to a broader segment of the education community. MTPE will make an effort to continually train



Samples of Mission to Planet Earth educational publications: a lithograph on the left and a fact book on the right.

the TRCN managers on programmatic content and the educational materials available. This will help maximize the effectiveness of the TRCN, enhance the knowledge of Earth system science, and expose the science to a greater share of educators and the general public.

Although a physical presence in each state is essential to increase the knowledge of Earth system science, it cannot reach all students and teachers. With educational technologies such as satellite communications and on-line computer information systems, every school, no matter how remote, can have immediate access to NASA information and educational materials. In expanding NASA's educational delivery systems for both followup activities and to serve those educators not reached through direct participation programs, MTPE has established various electronic delivery systems. Because printed and electronic publications are required to supplement the curricula taught by teachers in their schools, MTPE will continue to produce education publications ranging from teacher guides, videotapes, and educational software to CD-ROM (compact disk-read only memory) products and video disks. In addition, NASA Spacelink will be used to electronically disseminate all printed and computer-based materials.



To increase the availability of NASA supplementary curriculum materials, MTPE has adopted a five-component dissemination strategy for materials, as follows:

- NASA Spacelink as the mechanism for the electronic dissemination of text and graphics
- NASA CORE for the dissemination of audiovisual materials
- The NASA Teacher Resource Centers for the dissemination of printed curriculum enhancement materials to teachers
- Teacher workshops and conferences for the dissemination of teacher enhancement products
- NASA distance learning initiatives to enable wider dissemination to the general public and allow the MTPE mission to directly reach important local, regional, and specialized communities with its story and products

The NASA Field Centers, the TRCN, Space Grant consortia, and satellite and on-line computer systems are excellent mechanisms for the dissemination of educational services and information. However, there are limits to what NASA can directly accomplish. Therefore, NASA is taking additional steps to develop high-leverage educational projects to support the national education reform movement—through partnerships with public and private organizations.



The estimated 20,000 teachers at the National Science Teachers Association National Conference interact with MTPE scientists.

Working in cooperation with other Federal, state, local, and private organizations, MTPE continues to leverage its activities more effective and efficiently.

In addition, the Office of MTPE will continue to leverage its activities to a broader segment of the educational community through the use of national education conventions. National conventions are also an opportunity to conduct demonstrations and provide hands-on training for educators on MTPE products. A core set of materials will be selected each summer during the development of the annual MTPE publication plan for the following year's national conventions. Involvement in these events and in major Earth science conventions provides an opportunity for MTPE personnel to coordinate and communicate with other agencies and organizations that are developing and managing Earth science education programs.

STRATEGY: Support the development of systemic change initiatives that incorporate Earth system science into the state and local education systems

To raise the awareness of Earth system science on a broad scale, simultaneous efforts from the bottom up and from the top down are needed. Formal education is driven by a system that varies, depending on state, locality, and institutional setting. Therefore, a series of parallel activities must take place to work within the existing university and precollege systems to influence degree plans and curriculum standards.

At the university level, MTPE will continue to use the Earth system science education program to provide NASA support to selected universities. This will lead to the development of introductory and upper-division courses in Earth system science that will be used to influence emerging Earth system scientists and other students of higher learning to develop a better knowledge of Earth as an integrated system.

At the precollege level, MTPE will continue to work with its U.S. Global Change Research Program's Federal partners to provide long-term support for the



Global Change State Team members interact with scientists at Langley Research Center, one of seven NASA Field Centers that hosted action planning workshops.

Global Change Education State Team Initiative. Teams from all 50 states are composed of representatives with expertise in curriculum development, educational policy, informal education, and environmental science. NASA's MTPE has fostered a relationship with the teams in support of individual action plans to incorporate global change concepts into state and local education systems. By developing a full-service environmental education clearinghouse for programs and resources through the Global Change Research Information Office, on-line support is available to the state teams and other education experts across the country.

STRATEGY: Develop greater support by scientists for broad science communication and education efforts

The researchers of MTPE are the greatest resources for communicating their findings to the public. Such a resource has not been utilized as efficiently as it could be. To encourage the natural feedback process, MTPE research announcements are reviewed to determine the appropriate mechanism for including an education component. Encouraging language, selection criteria, and

supplemental grants are possible methods to emphasize the importance of communicating MTPE research with a diverse audience to the potential principle investigators.

As educational products and programs are developed, scientists should team with educators in the future on integrated education product teams. The science message must maintain integrity, yet be communicated in a useful way to educators at all levels.

STRATEGY: Make information and assessments accessible to the broad continuum of MTPE information customers, including the general public, media, publishers, industry, and so on

MTPE must work closely with the Office of Public Affairs to develop a science communication strategy for the near and long terms. As new media are developed, MTPE must take advantage of the emerging technologies, while maintaining a parallel set of traditional mechanisms for reaching the portions of the population that are not equipped for the new means of receiving information.

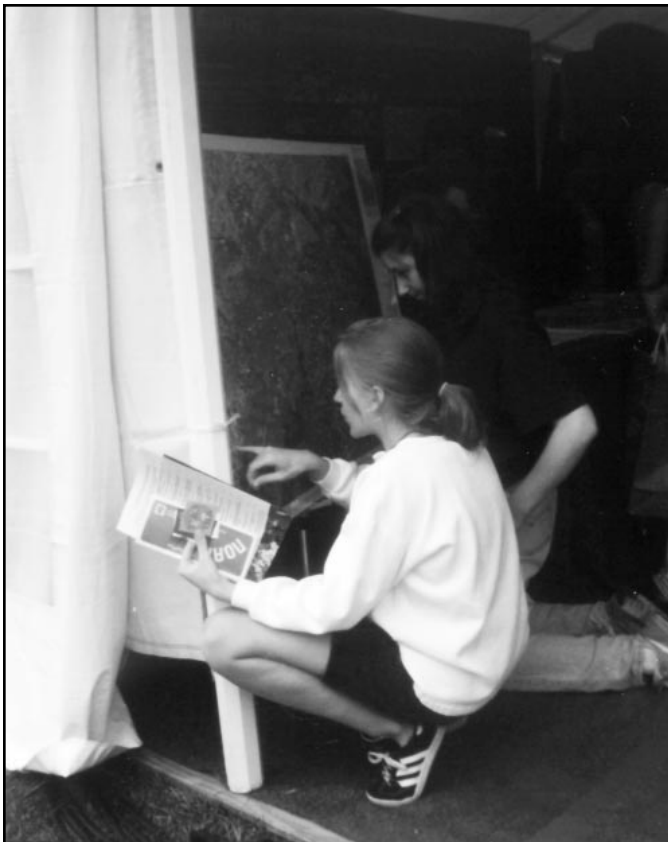
To encourage the use of technology to disseminate information, printed products and images should be made available on the Internet through different paths. The MTPE Home Page and the Education Division's Spacelink should be used routinely to provide accessibility to program information and resources, as well as provide linkages to more information over the Internet.

MTPE, in cooperation with the Office of Public Affairs, has identified the following objectives for communicating MTPE themes and messages to a broad audience base:

- Enhanced science, mathematics, and technology literacy
- Increased awareness of MTPE's unique contributions to understanding the Earth system
- Increased recognition of the value of MTPE science and technology to our daily lives
- Improved access to information



- Enhanced Earth system science research capability
- Increased number of external communication partnerships
- Expanded commercial application and use
- Increased efficiency through the leveraging of Federal resources, particularly global change agencies



Visitors interacted with exhibits and MTPE scientists at the Earth Day 25th anniversary celebration in Washington, D.C.



APPENDIX 1

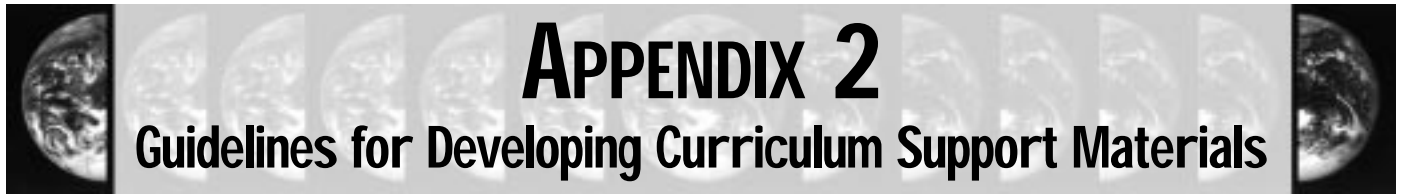
MTPE Education Unsolicited Proposal Process

To rank education activities within MTPE and make them more robust, in concert with the strategy objectives, MTPE established a peer review process that involves scientists and educators in a mail and panel review of all unsolicited proposals that come into the MTPE office. The process incorporates external peer review by scientists and educators to determine each proposal's educational and scientific merit, as well as an internal NASA panel review to evaluate the proposal against the objectives of the strategy. The result is a cooperative venture between the MTPE office and Headquarters Education Division to review proposals from NASA Field Centers and outside organizations in a fair and equitable manner. The feedback from the external and internal reviews are shared with principal investigators who receive awards, with the intention of strengthening the potential impact of the activity and its relevance to MTPE strategic objectives.

NASA project offices at each of the Field Centers are encouraged to submit to the process to gain an objective evaluation of a proposed project or proposed continuation of an ongoing project. If Headquarters funding is sought, then submission to the process is mandatory. NASA project offices are encouraged to combine forces and leverage existing programs to provide an Earth system science context for educational activities.

Proposals are awarded based on panel recommendations and available funding. Guidelines for submitting an unsolicited proposal to NASA are available from the Headquarters Acquisition Division at the following address:

**NASA Headquarters
Code CW
Washington, DC 20546-0001**



APPENDIX 2

Guidelines for Developing Curriculum Support Materials

- Identify the audience (grade level, in-service teacher versus pre-service, and so on) prior to development
- Determine the audience's need
- Identify the dissemination plan prior to development (see dissemination policy)
 - Investigate the parallel dissemination of products (high-technology and low-technology for equity purposes)
- Make use of existing materials within and external to NASA to the maximum extent possible
- Explore the possibility of leveraging material development with the outside group(s)
- Use the National Science Standards as a framework to guide the development of lessons and activities
- Construct a development team composed of a minimum of the following expertise:
 - Earth system science expert
 - Professional curriculum developer, familiar with the National Science Standards
 - Media specialist
 - Instructional designer
 - Evaluation expert
- Determine the goals and objectives of the product
- Establish use-appropriate metrics for success from the onset (see metrics)
- Establish a long-term plan for evaluation
- Construct assessment procedures
- Field test prior to broad dissemination
- Provide copies when completed to the MTPE Education Strategy Team to facilitate coordination



APPENDIX 3

Evaluation of NASA's Education Programs

The National Science and Technology Council's "Strategic Planning Document for Meeting the 21st Century" by the Committee on Education and Training cites the following as a major focus area:

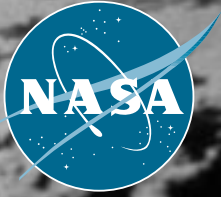
Promoting efforts to determine the effectiveness of Federal investments in science, mathematics, engineering, and technology education and training programs.

Evaluation and assessment are required by Federal law, as the result of the Government Performance and Results Act of 1993. The purpose of the act is to initiate program performance reform by setting program goals, measuring program performance against those goals, and reporting publicly on progress.

NASA's Education Division has developed a NASA-wide Education Program Evaluation System with goals, standardized indicators, and a wide capture of data. In response to National Performance Review recommendations, the process is paperless, thus providing on-line NASA-wide data collection and analysis capability.

After completing a beta test of the Education Division Computer Aided Tracking System (EDCATS), the operational phase of the program will be initiated. This milestone is targeted for the fall of 1996. All NASA education programs will use the system, including those activities supported by program offices within NASA. The MTPE Education Strategy Team has agreed to use the on-line system to evaluate and assess all educational activities. Independent studies and reviews will be conducted in parallel with the automated system on individual programs, as needed.

As new education programs are developed, the evaluation and assessment questions should be identified in cooperation with the corresponding NASA Field Center's Education Division. A standard list of these questions will be available prior to the beginning of the operational phase from any of the NASA Field Center education offices.



National Aeronautics and
Space Administration

